PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in and relating to Centrifugal Compressors

We, THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, a British Company, having its registered office at Crown House, Aldwych, London, W.C.2, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to centrifugal compressors having an impeller, and a diffuser which is seated on and secured to the compressor casing for converting velocity energy of a medium impelled by the impeller into pressure energy. More particularly, the invention relates to compressors used as superchargers on aircraft and operated at high speeds of the order of 20,000 rpm. Difficulties have been experienced in the past with compressors having shroudless impellers due to high temperature and high stresses set up in the casing during operation. The casing is ordinarily made in two halves bolted together. High stresses set up in the casing have the tendency to force one casing half away from the other, thereby increasing the clearance between the free edges of the impeller blades and the adjacent casing wall, resulting in a substantial reduction of the compressor efficiency and economy.

The object of our invention is to provide an improved construction and arrangement of centrifugal compressors which may be safely operated at high speeds and temperatures without materially distorting the compressor casing.

In the accompanying drawing Fig. 1 illustrates a turbosupercharger for aircraft embodying our invention; Fig. 2 is an exploded perspective view of two parts of Fig. 1; and Fig. 3 shows the parts of Fig. 2 assembled.

The turbosupercharger illustrated by way of example comprises an exhaust gas-operated turbine having a nozzle box 10 with a flanged inlet portion 11 for receiving exhaust gases. The gases are discharged from the box 10 through a nozzle structure 12 into a bucket wheel 13 which is supported on an overhung portion of a shaft 14. The shaft 14 is rotatably supported on a bearing structure 15 and has another overhung portion to the left of the bearing structure to which an impeller 16 is secured by means of a nut 17. The bearing structure 15 has an outer casing forming a spider with arms 18 supporting the nozzle box 10 by means including an annular baffle or partition 19 and bolts 20. The partition 19 also serves to reduce heat transfer from the box 10 to the bearing 15.

The centrifugal compressor includes the aforementioned impeller 16 which is driven by the turbine and has an impeller disc 21 with a plurality of impeller blades 22 integrally formed therewith. The impeller is disposed in a casing which comprises two halves or walls 23, 24 which with respect to their location on an aircraft may be termed inner and outer halves respectively. The two halves are secured together by means of a plurality of bolts 25. The inner half 23 has a central substantially cylindrical portion 26 which forms the inlet of the compressor. Outer portions of the casing halves form a discharge scroll 27 with a flanged discharge conduit 28. The discharge scroll in the present example has circumferentially spaced cooling and reinforcing ribs 29. The cross-sectional area of the scroll increases gradually towards the outlet 28. In the upper part of Fig. 1 this area is about minimum. Air or like medium impelled by the impeller is conducted to the scroll 27 through a diffuser 30. The diffuser 30 has an inner side wall or ring 31, an outer side wall 32, and a plurality of circumferentially spaced diffuser vanes 33 integrally formed with the side walls 31, 32. Radially outer portions of the side walls 31, 32 have openings 34, that is, these outer portions between adjacent vanes are cut away or saw-toothed in known manner to permit lateral as well as radial discharge of air or like medium from the diffuser into the scroll. The diffuser walls have inner cylindrical portions seated on shoulders 35 and 36 of the inner and outer casing halves 23, 24. The outer diffuser wall 32 has circumferentially spaced bosses 37 for receiving the inner

ends of staybolts 38. These staybolts have intermediate portions with collars for accurately spacing the diffuser wall 32 from the outer casing wall 24. Outer portions of the staybolts are secured to the outer casing 24 by means of nuts 39. In addition, a reinforced inner edge portion of the diffuser wall 32 is secured to the casing 24 by a row of bolts 40. Thus, one wall of the diffuser, in the present example the outer wall, is rigidly secured to and supported on the outer casing wall 24.

According to our invention means are provided for rigidly attaching the inner wall 31 of the diffuser on the inner casing half 23 in order to prevent the inner casing half from moving away from the adjacent impeller edges and thereby maintaining a substantially constant clearance 41 between said edges and the adjacent inner surface of the casing. This is important with regard to shroudless impellers because an increase of said clearance reduces materially the efficiency of the impeller. Such rigid support is particularly necessary in compressors in which the scroll along a part of its circumference is located inside the outer diameter of the impeller. In the drawing it will be noted that the left-hand upper part of the scroll is located outside the outer diameter of the impeller. In the lower part of the drawing the scroll curves inwardly and is partly located substantially inside the diameter of the outer part of the impeller. In other words, it has an inner diameter substantially smaller than the outer diameter of the impeller. In the lower part of the drawing the outer wall of the scroll is closely spaced or directly attached to the inlet conduit 26 of the casing while in the upper part of the drawing the wall of the scroll is radially spaced from the inlet conduit 26. The purpose of curving the scroll gradually inward towards the inlet conduit 26 as its cross-sectional area increases is to keep its over-all outer dimensions at a minimum. With such arrangement a portion, sometimes termed a " shelf " 42 of the compressor casing which forms part of the impeller chamber is not restrained at its outer end by other portions of the casing from deflecting axially away from the impeller chamber. When subject to high pressure and temperature the inner casing half or wall 23 has a tendency to move or buckle away from the impeller. This tendency is especially great with regard to the shelf 42 when unsupported or free at its outer end.

In order to restrain the casing, particularly the shelf portion, from deflecting during operation, means are provided for securely attaching such portion to the inner wall of the diffuser. In the present example the inner casing half is secured to the inner diffuser wall by a bayonet connection. To this end the inner diffuser wall 31 is provided with a row of lugs 43 and the inner casing half or wall 23 is provided with a row of cooperating projections 44 having chamfered edge portions 45 and adapted to fit into grooves 46 formed between the lugs 43 and the inner diffuser wall 31.

During assembly the inner casing wall 23 is placed onto the inner diffuser wall 31 with the projections 44 located between the lugs 43. Thereupon the casing half 23 is rotated to move the projections 44 into the grooves 46 (Fig. 3). With this arrangement the diffuser is supported and rigidly secured to one casing half and in turn acts as a support of the other casing half, especially the shelf portion thereof, preventing deformation of the latter during operation. The bayonet connection between the adjacent portions of the inner diffuser wall 31 and the inner casing half also assures a tight joint between these parts during operation, thus preventing leakage of fluid through said joint from the discharge scroll into the inlet of the diffuser.

In the present instance we have shown additional means for stiffening the casing in the form of cooperating eccentric annular flanges 47 and 48 on the outer diffuser wall 32 and the outer casing half 24 respectively. These flanges are machined and abut each other and together with other portions of the casing form an annular space 49 of varying cross-section. With a tight fit between the cooperating flanges 47, 48 there is little leakage of fluid from the scroll into the space 49 which broadly constitutes a packing chamber to reduce leakage of compressed medium from the scroll.

The outer casing half or wall 24 has a plurality of circumferentially spaced bosses 50 secured to the arms 18 of the bearing 15 by means of circumferentially spaced bolts and nuts 51 to support the compressor casing on the spider of the bearing 15.

Thus, with our invention we have accomplished an improved construction and arrangement of centrifugal type compressors having shroudless impellers and diffusers attached to the walls of the compressor. One diffuser wall is bolted to one casing half of the compressor and the other diffuser wall forms a bayonet connection with the other casing half or wall, preventing the latter from moving away from the free edges of the impeller blades, thus maintaining small clearance between

the compressor casing and the impeller and also maintaining a tight fit between the diffuser wall and the compressor casing.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A centrifugal compressor comprising a casing constructed of two halves forming an impeller chamber and a scroll, a diffuser having axially spaced walls secured together, one of the walls being bolted to one casing half, and a bayonet connection between the other wall and the other casing half.

2. A centrifugal compressor comprising a casing having two halves forming an impeller chamber and a scroll, a shroudless impeller rotatably mounted in the impeller chamber, a diffuser having axially spaced annular walls and circumferentially spaced vanes integrally formed with the walls, the casing halves having shoulders for supporting the diffuser walls, one diffuser wall being bolted to one casing half and a bayonet connection between the other diffuser wall and the other casing half.

3. A centrifugal compressor comprising a casing having an outer and an inner half secured together and forming an impeller chamber and a scroll, the inner casing half forming an inlet, an impeller mounted in the impeller chamber and having a disc with a plurality of circumferentially spaced blades integrally formed thereon and having free edges forming a close clearance with an adjacent wall portion of the inner casing half, a diffuser having outer and inner walls engaging the outer and inner casing halves respectively, bolt means securing the outer diffuser wall to the outer casing half, and a bayonet connection securing the inner casing half to the inner diffuser wall.

4. A centrifugal compressor comprising a casing having an outer and an inner half secured together and forming an impeller chamber and a scroll, the inner casing half forming an inlet, an impeller mounted in the impeller chamber and having a disc with a plurality of circumferentially spaced blades integrally formed thereon and having free edges forming a close clearance with an adjacent wall portion of the inner casing half, a diffuser located substantially in the scroll and having outer and inner walls engaging the outer and inner casing halves respectively, bolt means securing the outer diffuser wall to the outer casing half, and a bayonet connection securing the inner casing half to the inner diffuser wall, a portion of the scroll having an inner diameter substantially smaller than the outer diameter of the impeller, thus forming a shelf portion which at its radially outer edge is restrained from axial deflection by the bayonet connection.

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A. S. CACHEMAILLE,
Crown House, Aldwych, London, W.C.2,
Agent for the Applicants.

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[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1

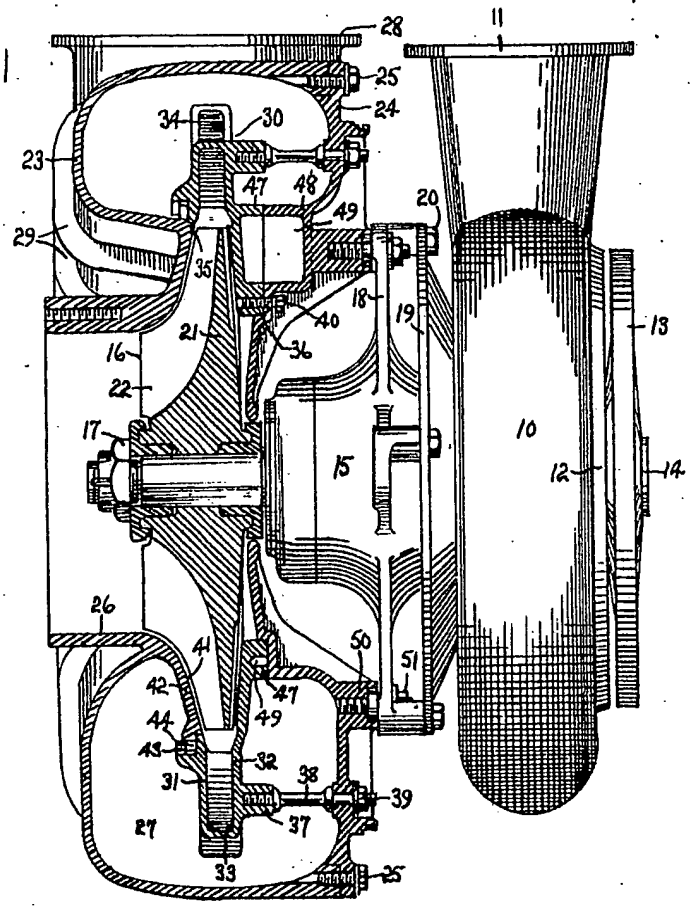

FIG. 3.

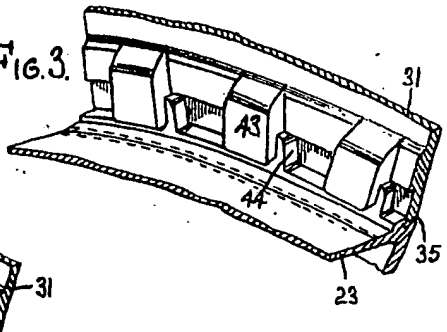

FIG. 2